PUBLIC NOTICE

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FCC SEEKS COMMENT ON WAIVER OF PART 25 LICENSING REQUIREMENT FOR RECEIVE-ONLY EARTH STATIONS OPERATING WITH THE GALILEO RADIONAVIGATION-SATELLITE SERVICE

IB Docket No. 17-16

Comment Date: February 21, 2017
Reply Comment Date: March 23, 2017

By a letter dated January 30, 2015, the National Telecommunications and Information Administration (NTIA) submitted a request by the European Commission (EC) for a waiver of the Federal Communications Commission's licensing requirements to permit non-Federal receive-only earth stations within the United States to operate with signals of the Galileo Radionavigation-Satellite Service (RNSS) system.[1] The FCC's rules require that receive-only earth stations operating with non-U.S. licensed space stations obtain a license.[2] NTIA requests that the FCC issue a public notice seeking comment on the EC's waiver request, and recommends granting the request. A copy of the NTIA letter, which includes the EC's request and supporting materials, is attached to this Public Notice.[3] Consistent with procedures previously established for consideration of such requests, we invite interested parties to comment on the waiver request.[4]

[1] Letter from Paige Atkins, Associate Administrator, Office of Spectrum Management, NTIA, to Mindel De La Torre, Chief, International Bureau, FCC and Julius Knapp, Chief, Office of Engineering and Technology, FCC (January 30, 2015) (*NTIA Waiver Request Letter*).

[2] *See* 47 CFR §§ 25.131(j)(1), 25.137.

[3] The supporting materials include: an October 23, 2013 Letter from Paul Weissenberg, Deputy Director-General, EC Enterprise and Industry Directorate-General, to Jonathan Margolis, Deputy Assistant Secretary, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State (*EC October 2013 Letter*), requesting a "block exemption, without limitation," of the FCC licensing requirement; an August 12, 2014 letter from Matthias Petschke, EU Satellite Navigation Programmes Director, EC Enterprise and Industry Directorate-General, to Jonathan Margolis, Deputy Assistant Secretary, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State (*EC August 2014 Letter*); and a technical exhibit providing information as specified in FCC Form 312, Schedule S (*EC Schedule S*).

[4] *See National Telecommunications and Information Administration Provides Information Concerning Executive Branch Recommendations for Waiver of Part 25 Rules Concerning Licensing of Receive-Only Earth Stations Operating with Non-U.S. Radionavigation Satellites*, Public Notice, 26 FCC Rcd 3867 (IB Mar. 15, 2011) (*RNSS Public Notice*). The *RNSS Public Notice* included an attached letter from Karl B. Nebbia, Associate Administrator, Office of Spectrum Management, NTIA, to Julius Knapp, Chief, Office of Engineering and Technology, FCC (Mar. 2, 2011) (March 2, 2011 NTIA Letter). *RNSS Public Notice*, 26 FCC Rcd at 3868-69.

The Waiver Request

The EC requests a waiver to permit all non-Federal receive-only earth stations to operate with the Galileo system's E1, E5, and E6 signals. It identifies the frequencies on which those signals are transmitted as follows: 1559-1591 MHz (E1); 1164-1219 MHz (E5); and 1260-1300 MHz (E6).[5] NTIA, in consultation with other relevant Executive Branch agencies, has reviewed the technical, operational, policy, and various other considerations in the EC's waiver request from the perspective of Federal operations and has concluded that the request satisfies NTIA's previously outlined criteria for recommending a waiver.[6] In its letter recommending grant of a waiver, NTIA notes that the *National Space Policy of the United States of America* specifically directs the United States to "engage with foreign [Global Navigation Satellite System (GNSS)] providers to encourage compatibility and interoperability, promote transparency in civil service provision, and enable market access for U.S. industry."[7] In addition, it notes that this policy provides that foreign positioning, navigation, and timing (PNT) services may be used to augment and strengthen the resiliency of the Global Positioning System (GPS). NTIA states that authorizing the use of Galileo PNT services in the United States, which will supplement GPS signals, will advance these goals and bring significant benefits to the American public.[8] NTIA also emphasizes that, pursuant to the 2004 *Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications*[9] between the EC (and its member states) and the United States, the Galileo system will be interoperable with GPS as well as radio frequency (RF) compatible with U.S. government systems and equipment already in use and operating in the RNSS bands.[10]

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[5] *EC Schedule S* at 6, 9.

[6] *See NTIA Waiver Request Letter* at 1-2 (citing criteria set forth in the March 2, 2011 NTIA letter, 26 FCC Rcd at 3868-69). The criteria are that: (1) granting the waiver is in the public interest; (2) the system complies with the United Nation's Space Debris Mitigation guidelines; (3) the grant of the waiver is consistent with U.S. International trade and other treaty obligations; (4) the waiver request is limited to the receive-only Radionavigation-Satellite Service (RNSS) (which includes positioning) and standard time and frequency satellite services; and (5) operation of the RNSS signals offered by the foreign Global Navigation Satellite System (GNSS) has been found compatible with U.S. government systems operating in the specified RNSS frequency bands. *Id.*

[7] *NTIA Waiver Request Letter* at 2 (citing the *National Space Policy of the United States of America* (June 28, 2010) at 5, *available at* http://whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf).

[8] *NTIA Waiver Request Letter* at 2.

[9] *Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications* (June 26, 2004) (2004 EC/US Galileo-GPS Agreement), *available at* http://www.gps.gov/policy/cooperation/europe/2004/gps-galileo-agreement.pdf. This agreement provides a framework for cooperation in the promotion, provision, and use of civil GPS and Galileo navigation and timing signals and services, value-added services, augmentations, and global navigation and timing goods. *Id.* Article I (Objectives). It also includes several other provisions, including provisions on national security compatibility. *Id.*

[10] *NTIA Waiver Request Letter* at 2, 4 (citing 2004 EC/US Galileo-GPS Agreement and the technical specifications set forth in the European GNSS (Galileo) Open Service Signal in Space Interface Control Document, Issue 1, Revision 1 (Sept. 2010), *available at* http://www.gsc-europa.eu/gnss-markets/segments-applications/os-sis-icd). "Radio frequency compatibility" means the assurance that one system will not cause interference that unacceptably degrades the stand-alone service that the other system provides. "Interoperability at the user level" is defined as a situation whereby a combined system receiver with a mix of GPS or Galileo satellites in view can achieve position, navigation, and timing solutions at the user level that are equivalent or better that can be achieved by either system alone. *See* 2004 EC/US Galileo-GPS Agreement, Article 2 (Definitions).

Overview of Public Notice

In this Public Notice, we seek comment on whether granting the requested waiver is in the public interest with respect to non-Federal operations.[11] Similar to NTIA, we also review the technical, operational, policy, and various other considerations in the EC's waiver request, but do so from the perspective of the potential issues pertaining to non-Federal operations, whether in the RNSS bands or in the bands adjacent to or near these bands. We emphasize at the outset that we agree with NTIA that authorizing the use of Galileo signals has the potential to bring significant benefits to the American public, such as improvements in the availability, reliability, and resiliency of space-based PNT services. In this Public Notice, we seek to fully develop a record on these potential benefits, and the ways in which our grant of a waiver would serve the public interest.

In recognizing these important potential benefits, we also note that the EC request is broad, requesting a waiver to permit all non-Federal receive-only earth stations (i.e., receivers) to operate with Galileo's E1, E5, and E6 signals that are transmitted in several different RNSS bands.[12] As identified and discussed below, the EC's request implicates additional issues that could potentially affect the Commission's spectrum management with regard to non-Federal operations in the bands allocated for RNSS or in adjacent or nearby bands, and we therefore request comment on these technical, operational, and policy issues to help inform our evaluation of the public interest benefits and other considerations associated with the requested waiver. As discussed below, these issues include: issues pertaining to international and U.S. spectrum allocations, including non-Federal allocations, in the affected bands; the potential impacts of the Galileo satellite signals on non-Federal receivers, including those in bands adjacent to or near the RNSS bands; and the electromagnetic compatibility of Galileo receivers and non-Federal transmissions in bands allocated to RNSS and in the bands adjacent or nearby to the RNSS bands.

In the final section of this Public Notice we focus on the important public interest benefits that would be associated with grant of a waiver for Galileo receivers. We invite comment on these significant public interest benefits, including the potential for improving the availability, reliability, and resiliency of space-based PNT services in our nation.[13] We also seek comment on any other considerations we should take into account as we evaluate the public interest associated with granting a waiver for operations in the United States with Galileo receivers.

Galileo Signals and RNSS Allocations

In this section, we seek comment on the signal characteristics of the Galileo system, which implicates technical, operational, and policy considerations related to the international and U.S. spectrum allocations, including non-Federal allocations.

E1 Signal. The EC indicates in the technical submissions included in its request that the Galileo E1 signal transmits over the 1559-1591 MHz frequency band, has a center frequency located at 1575.42 MHz and an assigned bandwidth of 32 megahertz.[14] The 1559-1610 MHz band is allocated in the International Telecommunication Union (ITU) Radio Regulations Table of Frequency Allocations to the

[11] *See RNSS Public Notice*, 26 FCC Rcd at 3867. As NTIA notes, that the Commission must make an independent public interest finding based on the public record. *See NTIA Waiver Request Letter* at 2.

[12] *See EC October 2013 Letter* (requesting a "block exemption, without limitation," of the licensing requirements for these receivers); *NTIA Waiver Request Letter* at 3.

[13] We note that commenting parties may request that specific information be kept confidential and withheld from public release under the procedures set forth in section 0.459 of our rules. *See* 47 CFR § 0.459.

[14] This technical and operational information is included in the EC's Schedule S submission. *EC Schedule S* at 6, 9.

RNSS on a primary basis,[15] and in the U.S. Table of Frequency Allocations to the RNSS on a primary basis for both Federal and non-Federal operations. This band also is allocated on a primary basis to the Aeronautical Radionavigation Service (ARNS) internationally, and domestically this primary ARNS allocation is available for both Federal and non-Federal use.[16] The Galileo E1 signal as described in the request transmits using the same center frequency that is used by the GPS L1 signal currently transmitting in this RNSS band, and has a signal bandwidth that is wider than the GPS II L1 signal bandwidth and the forthcoming GPS III L1C signal, but within the RNSS allocation.[17] The EC's request specifies the E1 signal at a maximum power level of 36.9 dBW equivalent isotropically radiated power (EIRP).[18]

Other source materials describe the E1 signal and bandwidth differently. For example, some sources describe the Galileo E1 signal bandwidth as 40 megahertz and extending below 1559 MHz.[19] We also note that, along with the Open Service (OS) signal (a civil navigation and timing service), the Galileo E1 signal includes the Public Regulated Service (PRS) signal, a civil navigation and timing service with a secure signal available only to authorized users. The PRS includes higher power levels than the OS signal at the outer edges of the E1 signal bandwidth.[20] A 40 megahertz bandwidth signal would extend into a band that is not allocated to the RNSS (specifically the 1525-1559 MHz band) but instead is allocated on a primary basis for Mobile Satellite Service downlinks.[21] As another example, an ITU filing from 2014

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[15] *See* ITU Radio Regulations, Article 5.

[16] 47 CFR § 2.106.

[17] The L1 signal associated with the current GPS II satellite constellation operates at 1565.19-1585.65 MHz, with a bandwidth of 20.46 megahertz, and the forthcoming L1C signal associated with the GPS III satellite constellation operates at 1560.025-1590.815 MHz, with a bandwidth of 30.69 megahertz. *See Global Positioning Systems Directorate Systems Engineering & Integration Interface Specification IS-GPS-200-H 24-SEP-2013 Navstar GPS Space Segment/Navigation User Interfaces* Sec. 3.3.1.1 Frequency Plan at 13-14, available at http://www.gps.gov/technical/icwg/.

[18] *EC Schedule S* at 4.

[19] *See, e.g.*, European Space Agency Navipedia Galileo Signal Plan (showing a bandwidth of 40 megahertz for the E1 signal), http://navipedia.net/index.php/Galileo_Signal_Plan (last visited June 22, 2016).

[20] The 2015 European GNSS (Galileo) Open Service Signal In Space Interface Control Document indicates that for the E1 signal, the Galileo "receiver reference bandwidth" is 24.552 megahertz for the E1 signal, with a center frequency of 1575.42 megahertz. *See* European GNSS (Galileo) Open Service Signal In Space Interface Control Document, OS SIS ICD, Issue 1.2 at 3, 4 (November 2015), *available at* http://www.gsc-europa.eu/gnss-markets/segments-applications/os-sis-icd. The signal associated with the Open Source service differs from the signal associated with PRS, although both share the same center frequency. *See* European GNSS (Galileo) Open Service Signal In Space Interface Control Document, OS SIS ICD, Issue 1.2 at 4 (November 2015). *See also* 2004 EC/US Galileo-GPS Agreement, Article 2(p) (defining "[s]ecured governmental service" as "a secured, restricted access satellite-based navigation and timing service . . . specifically designed to meet the needs of authorized governmental users") and Article 2(g) (describing the PRS as a secured governmental service). Under the terms of the 2004 EC/US Galileo-GPS Agreement, PRS is outside the scope of Articles 5 (Standards, Certification, Regulatory Measures, and Mandates) and 6 (Non-Discrimination and Trade). *Id.*

[21] *See* 47 CFR § 2.106. Within the United States, operation of land, maritime, and aeronautical receiving earth stations (serving commercial and Federal government customers) is permitted over several U.S. and foreign MSS networks throughout the 1525-1559 MHz frequency band pursuant to the U.S. Table of Frequency Allocations and FCC Part 25 satellite service rules. 47 CFR §§ 2.106, 25.115, 25.142, 25.202(a)(4)(iii)(A). Within the United States, operation of an Ancillary Terrestrial Component (ATC) to an MSS network also is permitted in the 1525-1559 MHz frequency band pursuant to footnote US380 in the U.S. Table and Part 25 of the Commission's rules. *See* 47 CFR §§ 2.106, footnote US380, 25.149, 25.253, 25.255.

specifies the E1 signal power that will be approximately 7 dB stronger than the power level specified in the EC's waiver request.[22]

E5 Signal. In its request, the EC indicates that the Galileo E5 signal will transmit over the 1164-1219 MHz band, with a center frequency at 1191.5 MHz and a bandwidth of 55 megahertz.[23] The 1164-1215 and 1215-1240 MHz bands are allocated internationally for the RNSS on a primary basis. Internationally, the 1164-1215 MHz band also is allocated on a primary basis to the ARNS, and the 1215-1240 MHz band is allocated on a primary basis to the Earth exploration-satellite service (EESS) (active), the radiolocation service (RLS), and the space research service (SRS) (active).[24] In the United States, the 1164-1215 MHz band is allocated on a primary basis to the RNSS and ARNS for both Federal and non-Federal use; the 1215-1240 MHz band is allocated on a primary basis to the RNSS, ARNS, EESS (active), RLS, and SRS (active) for Federal use, and on a secondary basis to the EESS (active) and SRS (active) for non-Federal use.[25] We note a slight variation in the center frequency of the E5 signal based on information in the 2015 Galileo Open Service Signal In Space Interface Control Document.[26] The EC specifies a maximum power level of 34.6 dBW EIRP.[27]

E6 Signal. The EC indicates that the E6 signal will transmit over the 1260-1300 MHz band, with a center frequency at 1280 MHz and an assigned bandwidth of 40 megahertz.[28] The 1240-1300 MHz band is allocated internationally on a primary basis for the RNSS, EESS (active), RLS, SRS (active), and on a secondary basis to the Amateur Radio service.[29] At the ITU World Radiocommunication Conference (WRC) 2000, an international primary RNSS allocation was adopted in the 1240-1300 MHz band, but this allocation has not been implemented in the U.S. Table of Frequency Allocations, for either Federal or non-Federal use.[30] In the United States, this band is allocated on a primary basis for Federal operations in the EESS, RLS, and SRS, and for non-Federal operations on a primary basis for the ARNS and on a secondary basis for the EESS, SRS, and Amateur Radio service.[31] The EC specifies the E6 signal at a

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[22] *Compare EC Schedule S* at 4 *with* Galileo-2 ITU Special Section No. CR/C/2542 MOD-1 of IFIC 2783 dated Nov. 25, 2014. We note that this and other similar ITU filings are subject to agreement by the U.S. Administration.

[23] *EC Schedule S* at 6, 9.

[24] *See* ITU Radio Regulations Article 5.

[25] 47 CFR § 2.106.

[26] That document states that the E5 signal is centered at 1191.795 MHz, not the 1191.5 MHz center frequency specified in EC's request. *See* Galileo Open Service Signal In Space Interface Control Document, Issue 1.2, at 3, 4.

[27] *EC Schedule S* at 4. This represents a 3 dB increase in E5 signal power over that specified in a 2009 ITU coordination filing. *See* Galileo-2 ITU Special Section No. CR/C/2542 MOD-1 of IFIC 2667 dated Dec. 18, 2009.

[28] *EC Schedule S* at 6.

[29] *See* ITU Radio Regulations, Article 5.

[30] *See Amendment of Parts 2, 25, and 87 of the Commission's Rules to Implement Decisions from World Radiocommunication Conferences Concerning Frequency Bands Between 28 MHz and 36 GHz and to Otherwise Update the Rules in this Frequency Range, Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum For Government and Non-Government Use in the Radionavigation-Satellite Service*, Report and Order, 18 FCC Rcd 23426, 23441, para. 34 (2003); *Amendment of Parts 2, 25, and 73 of the Commission's Rules to Implement Decisions from the World Radiocommunication Conference (Geneva, 2003) (WRC-03) Concerning Frequency Bands Between 5900 kHz and 27.5 GHz and to Otherwise Update the Rules in this Frequency Range*, Report and Order, 20 FCC Rcd 6570, 6608, para. 101 (2005).

[31] 47 CFR § 2.106. Under Part 97 of the Commission's rules, amateur stations transmitting in the 1240-1300 MHz band must not cause harmful interference to, and must accept interference from, stations authorized by: the U.S. Government in the ARNS, EESS (active), RLS, or SRS (active); the FCC in the ARNS; and other nations in the

maximum power level of 35.1 dBW EIRP.[32] An ITU filing from 2014 specifies an E6 signal power approximately 6 dB stronger than the power level specified in the EC's waiver request.[33]

For all three signals, we request any clarification regarding Galileo signal composition (e.g., whether PRS is included), bandwidth, and power, as appropriate, with regard to the EC's request. If Galileo satellites transmit signals at the higher power levels or different (e.g., wider) bandwidth than is specified in ITU filings and the other documents such as those discussed above,[34] to what extent should any waiver grant be limited to the technical parameters in EC's waiver request?

To the extent that the Galileo signals do not conform to the U.S. Table of Frequency Allocations, we seek comment on whether, on our own motion, we should waive the relevant provisions in Part 2 of the Commission's rules.[35] Consistent with our general approach in connection with such waivers, any such waivers would be subject to a condition that operations are on a non-interference, non-conforming basis (i.e., the Galileo signals shall not cause harmful interference to authorized operations and operations with the Galileo signals cannot claim protection from harmful interference with respect to authorized operations on frequencies outside of the RNSS allocation).[36]

Potential Impact relating to Galileo Satellite Signals and non-Federal Receivers Operating with Various Services

E1 Signal. We seek comment on whether E1 transmissions raise any interference or other concerns with respect to non-Federal RNSS, ARNS, and Mobile Satellite Service (MSS) receiver operations. We do not anticipate any electromagnetic compatibility issues with respect to non-federal reception of the current GPS L1, future GPS L1C, or ARNS signals since NTIA has concluded there are no RF compatibility issues with Federal operations, and we are unaware of any material differences in the general types of operations conducted by Federal and non-Federal users. We request comment on this assessment. We also seek comment on whether the Galileo E1 signal transmissions raise any interference concerns with respect to any other non-Federal services authorized to operate in adjacent or nearby bands, such as MSS earth station receivers in the 1525-1559 MHz band (including the MSS-augmented GPS receivers). Due to frequency separation and satellite geometry, we do not expect that Galileo E1 signal

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EESS (active), RLS, RNSS (space-to-Earth) (space-to-space), or SRS (active). *See* 47 CFR §§ 97.301(a), (e), 97.303(b), (d), and (o)(1)-(3).

[32] *EC Schedule S* at 4.

[33] *See* Galileo-2 ITU Special Section No. CR/C/2542 MOD-1 of IFIC 2783 dated Nov. 25, 2014. As noted above, this and other similar ITU filings are subject to agreement by the U.S. Administration.

[34] We note that 2004 EC/US Galileo/GPS Agreement provides certain flexibility with regard to changes in signal structures in order to maintain and improve the quality and security of services, to respond effectively to unforeseen changes in technology, user needs, and the spectrum environment, and to pursue modernization and development of their respective Galileo and GPS systems while maintaining the security and market benefits of compatible and interoperable common civil signals. *See* 2004 EC/US Galileo/GPS Agreement, Article II, paras. 4-7. In addition, as noted *supra* note 22, ITU filings are subject to agreement by the U.S. Administration.

[35] 47 CFR §§ 2.102(a) and 2.106.

[36] The Commission has granted a waiver of the U.S. Table of Frequency Allocations for non-conforming uses "when there is little potential interference into any service authorized under the Table of Allocations and when the non-conforming operator accepts any interference from authorized services." *See, e.g.*, *Application of Fugro-Chance, Inc.*, Order and Authorization, 10 FCC Rcd 2860, 2860, para. 2 (IB 1995); *Hughes Network Systems, LLC*, Declaratory Ruling, 26 FCC Rcd 8521, 8525, paras. 12-14 (IB 2011); *Boeing Company*, Order and Authorization, 16 FCC Rcd 5864, 5866-67, paras. 8-9 (IB and OET 2001).

transmissions raise interference concerns with respect to MSS space station receivers operating above 1610 MHz, but we welcome any comments on this matter.

E5 Signal. We seek comment on whether E5 transmissions raise any interference or other concerns with respect to non-Federal receiver operations. We do not anticipate any electromagnetic compatibility issues with respect to non-Federal reception of GPS L5 signals, since NTIA has concluded that there are no RF compatibility issues with respect to U.S. Government systems operating in the RNSS frequency bands and specifically that the Galileo signals are compatible with the GPS II L5 signal in the 1164-1215 MHz band.[37] With respect to ARNS systems in the 1164-1215 MHz band, we note that coordination has been ongoing since 2003 through the required ITU Resolution 609 consultation processes specified in footnote 5.328A of Article 5 of the ITU Radio Regulations.[38] The United States and the EC have coordinated operation of the Galileo system with GPS, pursuant to the 2004 EC/U.S. Galileo-GPS Agreement.[39] The GPS II L2 signal operates in the 1215-1240 MHz band and portions may overlap with the upper portions of the Galileo E5 signal. We seek comment on any potential impact from the Galileo E5 signal to non-Federal operations with the GPS L2 signal. In addition, we seek comment on the potential impact of the Galileo E5 signal to any primary authorized non-Federal services operating below 1164 MHz particularly operations under the ARNS and aeronautical mobile service allocations in the 960-1164 MHz band, as well as any potential impact to secondary EES and SRS allocated above 1215 MHz. Recognizing that NTIA does not expect RF compatibility issues with Federal stations operating these same services, we likewise do not anticipate electromagnetic compatibility issues for non-Federal stations but seek comment to confirm.

E6 Signal. We seek comment on whether the E6 signal has the potential to cause interference to primary non-Federal ARNS and secondary EESS and SRS in the 1240-1300 MHz band. NTIA indicates that the U.S. Government operates non-RNSS systems in portions of this band, but that Federal agencies have agreed that they can mitigate potential interference from the Galileo system.[40] Recognizing that NTIA does not expect RF compatibility issues with primary Federal stations operating in these same services, we likewise do not anticipate electromagnetic compatibility issues for non-Federal stations but seek comment to confirm.

Potential Impacts relating to Galileo Receivers and Non-Federal Operations

As noted, the EC seeks a broad waiver to permit all non-Federal receive-only earth stations (i.e., receivers) to operate with Galileo's E1, E5, and E6 signals.[41] In this section, we seek comment on potential impacts associated with these receiver operations with Galileo signals, including the electromagnetic compatibility of such receivers and non-Federal transmissions in the frequency bands

[37] *NTIA Waiver Request Letter* at 4 (Galileo signals are compatible with the GPS L1 and L5 signals).

[38] *See* ITU Radio Regulations, Article 5, footnote 5.328A. Footnote 5.328A states: "Stations in the radionavigation-satellite service in the band 1164-1215 MHz shall operate in accordance with the provisions of Resolution 609 (Rev.WRC-07) and shall not claim protection from stations in the aeronautical radionavigation service in the band 960-1215 MHz. No. 5.43A does not apply. The provisions of No. 21.18 shall apply." *Id.*

[39] *See generally* 2004 EC/US Galileo-GPS Agreement.

[40] *See NTIA Waiver Request Letter* at 4.

[41] *See EC October 2013 Letter* (requesting a block exemption, without limitation, of the licensing requirements for these receivers).

allocated to the RNSS and those adjacent to or near the RNSS bands.[42] To assess the potential impact of granting the EC's request, we request information about the receivers, including how they are currently designed to receive the Galileo signals and/or GPS signals and the receivers' electromagnetic compatibility with other uses of spectrum in the RNSS bands or adjacent or nearby bands.[43] In considering the EC's waiver request, we also ask for comment on whether there are any clarifications, limitations, or conditions that should be attached to any waiver grant that would serve the public interest, in addition to those discussed above.[44]

Operations with the Galileo E1 signal. We first seek comment on the potential impact that granting the requested waiver for all non-Federal receivers operating with the Galileo E1 signal could have with respect to non-Federal transmitter operations in the 1559-1610 MHz band. As discussed above, NTIA states that operation of the E1 signal (as well as the E5 signal) offered by the Galileo system and the U.S. Government systems operating in the RNSS frequency bands are RF compatible, and that the Galileo system will be interoperable with GPS under the terms of the 2004 EC/US Galileo-GPS Agreement.[45] Accordingly, we anticipate that the non-Federal receivers that operate with the Galileo E1 signals and GPS are electromagnetically compatible and interoperable, and that the Galileo receivers would not raise any concerns regarding any other non-Federal transmitter operations in the 1559-1610 MHz band. We seek comment on this assessment.

We next seek comment on the potential impact that granting the requested waiver for all non-Federal receivers to operate with the Galileo E1 signal could have with respect to any non-Federal operations in bands outside of the 1559-1610 MHz RNSS allocation. In order to assess the potential impact, we request information on the non-Federal receivers that would operate with the Galileo E1 signal transmissions, including how these devices are designed both to receive the Galileo signal and to promote electromagnetic compatibility with operations in the adjacent or nearby bands.[46] With regard to receiving the E1 signal, we request information on characteristics, including the RF front-end filter (e.g., band-pass

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[42] In its spectrum management and licensing authority for non-Federal spectrum use, the Commission generally seeks to promote electromagnetic compatibility among authorized users, harmonize spectrum use, provide for efficient use of spectrum, and accommodate new technologies and services.

[43] Under ITU regulations, transmitting and receiving equipment intended to be used in a given part of the frequency spectrum should be designed to take into account the technical characteristics of transmitting and receiving equipment likely to be employed in neighboring and other parts of the spectrum. *See* ITU Regulations, 3.3; *see also* ITU Regulation 3.13 ("performance characteristics of receivers should be adequate to ensure that they do not suffer from interference due to transmitters situated at a reasonable distance and which operate in accordance with [the ITU] Regulations").

[44] As noted above, commenters may request that specific information be withheld from public release, as appropriate. *See* 47 CFR § 0.459.

[45] *NTIA Waiver Request Letter* at 2, 4. We note however that no agreements are in place between the U.S and Administrations responsible for other GNSS networks. Nor are we aware of any compatibility or interoperability agreements in place between the EC and other Administrations responsible for other GNSS networks.

[46] In requesting information about electromagnetic compatibility associated with these Galileo receivers, we note that the European Union is in the process of implementing directives issued in 2014 that recognize the importance of receiver capabilities in ensuring the efficient use of spectrum, and promote the use of radio equipment (both receivers and transmitters) that have an adequate level of electromagnetic compatibility. *See* Directive 2014/53//EU of the European Parliament and of the Council (16 April 2014) (relating to making radio equipment that is available in the European Union market) (Radio Equipment Directive); Directive 2014/30/EU of the European Parliament and of the Council (26 February 2014) (relating to electromagnetic compatibility). The 2014 Radio Equipment Directive became effective on June 13, 2016, and establishes various requirements concerning performance of receivers that enter the European market, including those associated with ensuring electromagnetic compatibility with shared or adjacent band operations.

filter), of the receivers that are designed to operate with this signal. In particular, we seek information on the extent to which such devices are designed to operate only with the Galileo signal or only with the Galileo E1 and GPS signals associated with the 1559-1610 MHz RNSS allocation. To what extent are the RF front-end filters of these receivers designed the same as, similarly, or differently, than the front-end filters of receivers operating with only the GPS signal, and in what ways? If they operate with both Galileo and GPS signals, are these receivers designed with a shared antenna and/or logic component (e.g., for improved accuracy obtained by including both Galileo and GPS signals) that would enable, or prevent, the ability to discriminate between the GPS and Galileo PNT determinations? To what extent are the Galileo receivers also designed to be capable of operating with other GNSS signal transmissions associated with this RNSS allocation?[47] Are there certain technical parameters associated with Galileo receiver design that apply to *all* receivers that would operate with the Galileo E1 signal (e.g., parameters generally agreed upon by device manufacturers in the industry), and if so, what are they? If not, how varied are the receiver front-ends for Galileo E1 devices? How might these variations change in the future? To what extent may they vary depending on the capabilities they may have today, or in the future, with respect to operating with Galileo/GPS systems or different multiple GNSS systems?

We also request information on how the Galileo E1 receivers are designed to help ensure electromagnetic compatibility with operations in adjacent or nearby bands. In designing and constructing the receivers, what assumptions are made about the RF environment, including the Galileo E1 and GPS signal transmissions and any other operations authorized in the adjacent MSS bands or other bands that potentially affect the RF environment. To what extent are Galileo E1 receivers designed the same as, or differently from, GPS receivers with respect to ensuring electromagnetic compatibility with other non-Federal operations? With regard to particular adjacent or nearby non-Federal operations, are Galileo receivers designed in ways that effectively mitigate interference from MSS operations above 1610 MHz?[48] Does a GNSS receiver with Galileo E1 signal capability effectively mitigate interference from a mobile Earth station operating at maximum power in the spectrum above 1610 MHz at a reasonable geographic separation distance? Are Galileo E1 receivers designed to mitigate interference from authorized MSS satellite downlink operations below 1559 MHz, such as the data channels for MSS-augmented GPS receivers?[49] In addition, to the extent that receivers that operate with Galileo E1 signals differ from GPS-only receivers, we seek comment on the electromagnetic compatibility of such Galileo E1 receivers and proposed terrestrial operations associated with the conditional L-band ATC authorization, which is currently under consideration in a pending Commission proceeding.[50] To what

[47] Though the Commission has not approved the use of any non-U.S. GNSS systems by non-Federal receivers in the United States, we recognize that other GNSS signals are transmitted in the 1559-1610 MHz RNSS allocation. Receivers designed to operate with Galileo alone, or with Galileo and GPS signals, may also be designed to be electromagnetically compatible with other GNSS signals associated with the RNSS allocation but, by the nature of their design, may be more susceptible to receiving potential interference from non-Federal transmitters that operate below 1559 MHz and/or above 1610 MHz which could affect the electromagnetic compatibility of these GNSS and non-Federal operations.

[48] Frequencies in the 1610-1626.5 MHz band are available for use by MSS systems, including an ancillary terrestrial component (ATC). *See* 47 CFR §§ 25.202(a)(4)(i), 25.254.

[49] Frequencies in the 1525-1559 MHz band are available for use by MSS systems, including an ATC. *See* 47 CFR §§ 25.202(a)(4)(iii)(A), and 25.253.

[50] Ligado Networks holds an MSS license for operations in the 1525-1559 MHz band that includes an ATC authorization, conditioned on addressing potential interference concerns relating to GPS operations in the 1559-1610 MHz band. In December 2015, Ligado filed new applications to modify its ATC authorization subject to specific conditions, and requested that the Commission allow it to proceed with deployment of terrestrial operations in specified portions – the 1526-1536 MHz, the 1627.5-1637.5 MHz, and 1646.5-1656.5 MHz bands – of the spectrum associated with its license. *See Comment Sought on Ligado's Modification Applications*, IB Docket Nos. 11-109 and 12-340, Public Notice, DA 16-442, 31 FCC Rcd 3802 (IB, OET, WTB, rel. Apr. 22, 2016). In this proceeding, three major GPS receiver manufacturers (Trimble, Garmin, and Deere) have reached agreements with Ligado, the

extent would some or all of the E1 receivers that also operate with GPS signals improve the interference resiliency of the receivers, or alternatively render them more vulnerable to interference from adjacent/nearby band operations than GPS-only receivers? Are there anticipated or potential changes in future receiver design that could significantly alter the electromagnetic compatibility of Galileo receivers and non-Federal operations in bands adjacent to or near the RNSS allocation? To the extent that the designs of different receivers operating with the Galileo E1 signal vary significantly (e.g., with regard to RF front-end design or the ability to mitigate interference from non-Federal operations in bands adjacent to or near the RNSS allocation), we request comment on whether this should affect our considerations with regard to granting approval of a waiver.

Finally, we request information concerning how receivers operating with the Galileo E1 signal are designed also with respect to operations with the Galileo E5 and/or E6 signal(s), and/or with operations with other GPS signals, in the 1164-1215 MHz, 1215-1240 MHz, or 1240-1300 MHz bands, and the extent to which the devices are designed to ensure electromagnetic compatibility with other GNSS signal transmissions associated with these RNSS allocation. For receivers that operate with the Galileo E1 signal, is there a separate RF front-end to support the E5 and/or E6 signals? What are the techniques to enhance the interference performance in the receiver design? In addressing these questions, we ask commenters to provide technical details illustrating the differences in design and interference rejection performance.

Operations with the E5 and E6 signals. We seek comment on the potential impact that granting the requested waiver for all non-Federal receivers to operate with the Galileo E5 signal could have on non-Federal operations in the 1164-1215 MHz or 1215-1240 MHz bands, with the Galileo E6 signal in the 1240-1300 MHz band, or any adjacent or nearby band. As indicated above, NTIA has stated that RF compatibility has been achieved between the Galileo system and Federal systems operating in the bands allocated internationally for RNSS, and that the Galileo system is interoperable with GPS.[51] We do not anticipate electromagnetic compatibility issues with respect to the receivers operating with Galileo E5 or E6 signals and non-Federal operations, including non-Federal Amateur Radio operations,[52] but nonetheless request comment on our assessment. We ask commenters to provide details of the assumptions concerning the RF environment that form the basis for receiver designs, as well as the same types of information on the RF front-end filter of receivers that are designed to operate with the Galileo E5 and E6 signals and GPS signals as we request for E1-capable receivers. Are there certain technical parameters associated with Galileo receiver design that apply to *all* receivers that would operate with the Galileo E 5 or E6 signal, and if so, what are they? How varied are the receiver front-ends for Galileo receivers that operate with these signals? We also request information on how the Galileo receivers are designed to promote electromagnetic compatibility and to mitigate interference from multiple sources when receiving Galileo signals over multiple frequency bands.

Public Interest Benefits and Other Considerations

Having sought comment above on various technical, operational, and policy considerations associated with the requested waiver, we here seek comment on the public interest benefits that are

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single FCC-authorized ATC operator in the L-band spectrum (1525-1559 MHz) that is adjacent to the RNSS band (1559-1610 MHz) where GPS L1 receivers operate. These receiver manufacturers do not object to the terrestrial licensee deploying base stations in the L-band spectrum below 1545 MHz under specific, agreed conditions. *See generally id.* at 3807.

[51] *NTIA Waiver Request Letter* at 4.

[52] *See supra* note 31 (concerning Amateur Radio).

associated with the Commission's grant of a waiver.[53] NTIA states that granting the requested waiver will enable Galileo signals to supplement GPS signals, thereby bringing significant benefits to the public by increasing service availability, reliability, and resiliency.[54] We seek to develop a full record of these benefits to inform our assessment of the public interest associated with granting a waiver for Galileo receivers. We also seek comment on any other considerations that we should take into account with respect to granting a waiver.

Service availability, accuracy, and reliability. We invite broad comment on the ways in which grant of a waiver would affect or improve service availability, accuracy, and/or reliability (e.g., through access to more RNSS satellite signals). In what specific ways would reception of the Galileo satellite signals improve satellite navigation services? We request comment on the specific types of infrastructure services or applications that would benefit from operating Galileo-capable receivers in the United States. What particular consumer applications would benefit? Are there other types of applications that would benefit? To the extent any non-Federal entity potentially may seek to operate with the PRS signal, we also request comment on whether there may be potential public safety and security applications that are associated with, and would benefit from, the use of the PRS signal. Are there ways in which granting a waiver could have a detrimental impact on GPS service availability, accuracy, and/or reliability? For example, could the co-processing of both Galileo and GPS signals in certain types of receivers decrease availability, accuracy, and/or reliability?

Resiliency. With regard to the potential use of the Galileo E1, E5, and E6 signals to improve the resiliency of GPS, we request comment (in addition to what may already have been provided in response to questions raised above) on how operations with such signals could or would improve resiliency to potential RF interference. Would devices augmented to receive signals from the Galileo satellite constellation in all cases be more resilient to signals of other non-Federal services (e.g., those that overlap or are adjacent to or near the E1, E5, and E6 signal bandwidths) than devices operating with GPS alone? In what ways do Galileo receivers improve resiliency against RF interference? Depending on the design, could certain types of receivers operating with Galileo signals potentially be more susceptible to interference from other operations, including adjacent or nearby operations (e.g., as a result of a wider RF front-end that is more susceptible to overload interference)?[55] We request that commenters provide sufficient details in explaining the bases for their comments. To the extent that there may be potential for increased interference susceptibility, how should the Commission take those concerns into account as it assesses the potential public interest benefits of authorizing Galileo-capable receivers? In evaluating grant of a waiver, should we consider placing conditions on the types of receivers to the extent that they may be more susceptible to interference from non-Federal services in adjacent or nearby frequency bands?

Other considerations. Finally, we seek comment on whether there are any other benefits or concerns that should be considered by the Commission in evaluating and taking action on the requested waiver.[56]

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[53] As noted above, commenters may request that specific information be withheld from public release, as appropriate. *See* 47 CFR § 0.459.

[54] *NTIA Waiver Request Letter* at 2.

[55] *See Wireless E911 Location Accuracy Requirements*, Fourth Report and Order, PS Docket No. 07-114, 30 FCC Rcd 1259, 1272-1273, para. 40 (2015) (*E911 4th R&O*) (noting that GNSS technologies used to augment GPS may increase potential exposure of devices to interference).

[56] We note that a favorable action on this matter would not authorize use of the Galileo system to support Enhanced 911 (E911) location services. A request for such use may require additional steps not contemplated by this public notice. *See E-911 4th R&O* at 1272-73, paras. 39-40.

Interested parties may file comments on or before **February 21, 2017** and reply comments on or before **March 23, 2017**. All comments are to reference **IB Docket No. 17-16**.

Pursuant to sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS). *See Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: http://apps.fcc.gov/ecfs/.

- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

  Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

  - All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. The filing hours are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes and boxes must be disposed of before entering the building.

  - Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9300 East Hampton Drive, Capitol Heights, MD 20743.

  - U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

People with Disabilities: To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0530 (voice), 202-418-0432 (tty).

This is a "permit-but-disclose" proceeding, subject to the Commission's *ex parte* rules.[57] Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation. Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter's written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are

[57] 47 CFR §§ 1.1200 *et seq.*

deemed to be written *ex parte* presentations and must be filed consistent with rule 1.1206(b), 47 CFR § 1.1206(b).

For further information, please contact Karl Kensinger, Satellite Division, International Bureau, at (202) 418-0773.

-FCC-

ATTACHMENT

UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Washington, D.C. 20230

JAN 30 2015

Ms. Mindel De La Torre
Chief, International Bureau
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Mr. Julius Knapp
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Request for Waiver of 47 C.F.R. §§25.131(j)(1) and 25.137 on behalf of the European Commission

Dear Ms. De La Torre and Mr. Knapp:

Please find enclosed a request submitted by the European Commission (EC) for a waiver of the Federal Communications Commission's (FCC) licensing requirements to enable the signals of the Galileo radionavigation-satellite service (RNSS) system to operate with receive-only earth stations within the United States. The National Telecommunications and Information Administration (NTIA), on behalf of the Administration, recommends that the FCC grant the EC's waiver request following a public notice and comment period. NTIA and the Executive Branch agencies have reviewed the technical, operational, policy, and other considerations of the waiver request and conclude that it meets the criteria NTIA previously established to grant the waiver.[1]

The FCC's rules require licensing of non-federal receive-only equipment operating with foreign satellite systems, including receive-only earth stations operating with non-U.S. licensed satellites.[2] On March 2, 2011, NTIA outlined the following criteria we will apply in considering whether to recommend waiver of these rules upon request by a foreign government to operate receive-only earth stations with a non-U.S. licensed RNSS system: (1) that granting the waiver is in the public interest; (2) that the system complies with United Nations Space Debris Mitigation guidelines; (3) that granting the waiver is consistent with international trade and other treaty obligations of the United States; (4) that the waiver request is limited to receive-only RNSS (which includes positioning) and standard time and

[1] *See* Letter from Karl B. Nebbia, Associate Administrator, Office of Spectrum Management, NTIA, to Julius Knapp, Chief, Office of Engineering and Technology, FCC (Mar. 2, 2011), *available at* http://www.fcc.gov/document/ntia-outlines-rules-waiver-criteria-receive-only-earth-stations-using-non-us-satellites (*NTIA March 2011 Letter*); *see also* FCC Public Notice, 26 FCC Rcd 3867 (Mar. 15, 2011), *available at* https://apps.fcc.gov/edocs_public/attachmatch/DA-11-498A1_Rcd.pdf.

[2] *See* 47 C.F.R. §§25.131(j)(1), 25.137.

frequency satellite services; and (5) that operation of the RNSS signals offered by the foreign RNSS system has been found compatible with U.S. Government systems operating in the specified RNSS frequency bands. NTIA provides below the results of our evaluation of the EC's waiver request in accordance with such criteria.

Granting the waiver is in the public interest.

While we understand that the FCC must make an independent public interest finding based on the public record, NTIA believes that granting the EC's waiver request is in public interest and would be consistent with the principles set forth in the FCC's 1997 *DISCO II Order*.[3] The *National Space Policy of the United States of America* provides that the United States must maintain its leadership in the service, provision, and use of global navigation satellite systems (GNSS) by providing continuous worldwide access, for peaceful civil uses, to the Global Positioning System (GPS) and its government-provided augmentations, free of direct user charges.[4] The *Space Policy* specifically directs the United States to "engage with foreign GNSS providers to encourage compatibility and interoperability, promote transparency in civil service provision, and enable market access for U.S. industry."[5] The *Space Policy* also states that foreign positioning, navigation, and timing services may be used to augment and strengthen the resiliency of GPS.[6]

Authorizing use of Galileo positioning, navigation, and timing services in the United States pursuant to a waiver of the licensing requirements will advance these national goals and bring significant benefits to the American public. The Galileo signals will supplement GPS signals, which will benefit end users by increasing service availability, reliability, and resiliency. The Galileo system will be interoperable with GPS under the current U.S. and European Union *Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications*.[7] Granting the EC's waiver of the licensing requirements for Galileo is therefore consistent with the purpose and objectives of that agreement. For example, a waiver will "provide satellite navigation users and equipment providers with a broader range of services and capabilities, leading to increased user applications, while assuring radio frequency compatibility with systems and equipment already in use."[8]

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[3] *See NTIA March 2011 Letter* at 2 n. 6 (citing Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Satellites Providing Domestic and International Service in the United States, *Report and Order*, IB Docket No. 96-11, 12 FCC Rcd 24094 (1997) (*DISCO II Order*).

[4] *National Space Policy of the United States of America* at 5 (June 28, 2010), *available at* http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf (*Space Policy*).

[5] *Id.*

[6] *Id.*

[7] *Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications*, Art. IV (June 26, 2004), *available at* http://www.gps.gov/policy/cooperation/europe/2004/gps-galileo-agreement.pdf (*2004 Agreement*).

[8] *Id.* at 5.

The system complies with *United Nations Space Debris Mitigation Guidelines.*

The Galileo system complies with the *United Nations Space Debris Mitigation Guidelines*.[9] The enclosed Technical Note provided by the EC shows that the Galileo system is being built and operated under the European Space Agency's (ESA) space debris mitigation requirements. Therefore, the Galileo system is subject to ESA's direct and effective regulation. The U.S. State Department confirmed that these requirements comply with *United Nations Space Debris Mitigation Guidelines*.

The grant of a waiver is consistent with U.S. international trade and other treaty obligations.

Granting the waiver request for the reception of Galileo signals without a license in the United States is consistent with U.S. trade and other treaty obligations. Specifically, granting the waiver is consistent with U.S. obligations under the General Agreement on Trade in Services, which is the World Trade Organization agreement that addresses the provision of services. Furthermore, the same criteria and procedures apply to any similarly situated foreign government seeking such a waiver.

In addition, the waiver would be consistent with the spectrum allocations established through the International Telecommunications Union (ITU). Allowing use of Galileo's signals in the United States conforms to the RNSS allocations in the ITU's International Table of Frequency Allocations for the frequency bands specified in the enclosed technical and operation description.

The waiver request is limited to receive-only RNSS (which includes positioning) and standard time and frequency satellite services.

The EC's waiver request is limited to receive-only RNSS (which includes positioning) and standard time and frequency satellite services. The enclosed request seeks "without limitation or further administrative burden, a block exemption of the requirements under Title 47 CFR 25.131(j)(1) [and] 25.137, which apply to all non-federal receive-only equipment operating with European GNSS signals, including receive-only earth stations operating with European GNSS radio navigation satellite services."

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[9] United Nations Office for Outer Space Affairs, *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space* (2010), *available at* http://www.unoosa.org/pdf/bst/COPUOS_SPACE_DEBRIS_MITIGATION_GUIDELINES.pdf.

Operation of the RNSS signals offered by the foreign RNSS system has been found compatible with U.S. government systems operating in the specified RNSS frequency bands.

Operation of the RNSS signals offered by the Galileo system are compatible with U.S. government systems operating in the specified RNSS frequency bands. In accordance with the *Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications* the United States and European Union agreed that GPS and Galileo shall be "radio frequency compatible."[10] The Galileo system technical specifications are documented in the *European GNSS (Galileo) Open Service Signal-in-Space Interface Control Document*.[11] The enclosed Satellite Space Station Authorizations Technical and Operational Description (FCC Form 312, Schedule S) identifies the following operating frequency bands:

- 1164-1215 MHz
- 1260-1300 MHz
- 1559-1591 MHz

NTIA and representatives of affected federal agencies have reviewed this technical information and determined that it complies with applicable rules and procedures established by the ITU. Further, after years of exchanges of information and discussions between U.S. and European Union technical representatives, NTIA and the federal agencies have sufficient information to conclude that operation of the Galileo signals are compatible with the L1 and L5 GPS signals in the 1559-1610 MHz and 1164-1300 MHz RNSS bands.

The U.S. Government also operates non-RNSS systems in portions of the 1260-1300 MHz RNSS frequency bands specified in the waiver request. Analyses and measurements have shown that Galileo signals will exceed established protection criteria of U.S. radio-determination systems currently operating in the 1240-1300 MHz band. However, the affected federal agencies have agreed that they can mitigate potential interference due to the signals' predictable (in time and location) occurrences, known signal structure and power, and non-stationary character.[12]

* * * * *

[10] *2004 Agreement*, Art. IV, para. 2. *See id.*, Art. II(o) ("Radio frequency compatibility" means the assurance that one system will not cause interference that unacceptably degrades the stand-alone service that the other system provides.)

[11] *European GNSS (Galileo) Open Service Signal-in-Space Interface Control Document*, Issue 1, Revision 1 (Sept. 2010), *available at* http://ec.europa.eu/enterprise/policies/satnav/galileo/files/galileo-os-sis-icd-issue1-revision1_en.pdf.

[12] NTIA anticipated that the FCC, prior to deciding to grant the waiver, will conduct its own review to confirm that the specific RNSS signals offered by the foreign RNSS system are compatible with non-Federal U.S.-licensed systems operating in the frequency bands specified in the waiver request. *NTIA March 2011 Letter* at n. 5.

In conclusion, NTIA and the federal agencies carefully reviewed all aspects of allowing Galileo RNSS signals to operate in connection with U.S.-based receive-only equipment and determined that grant of the requested waiver is consistent with the criteria developed by NTIA. Accordingly, we respectfully request that the FCC assign the request an "SES-MSC" file number in the International Bureau Filing System and issue a public notice providing an opportunity for comment on the EC waiver request. If non-Federal stakeholders raise significant concerns, please inform NTIA. The NTIA contact point for this request is Edward Drocella who can be reached at (202) 482-2608 or edrocella@ntia.doc.gov.

Sincerely,

Paige Atkins
Associate Administrator
Office of Spectrum Management

Enclosure

EUROPEAN COMMISSION
ENTERPRISE AND INDUSTRY DIRECTORATE-GENERAL

Deputy Director-General

Brussels, 23. 10. 2013
ENTR/H3/AS/gj/ Ares (2013) 2618737

Mr Jonathan Margolis
Deputy Assistant Secretary
Bureau of Oceans and International
Environmental and Scientific Affairs
U.S. Department of State
2201 C Street NW
Washington, DC 20520
United States of America

Dear Mr Margolis, Jonathan,

The close cooperation on Global navigation satellite systems between the European Union and the United States of America is a joint success. Our collaborative efforts on various issues in this field, in particular on trade and civil applications. have brought very fruitful results.

In this context, and in view of further enhancing our relationship, I would be much obliged if you could request the Federal Communications Commission to grant, without limitation or any further administrative burden, a block exemption of the requirements under Title 47 CFR 25.131 (j)(1), 25.137, which apply to all non-federal receiver only equipment operating with European GNSS signals, including receive-only earth stations operating with European GNSS radio navigation satellite services.

This waiver of the FCC's licence for Galileo would be a useful complement to the activities carried out under the 2004 EU-US agreement on satellite navigation. It would continue to affirm the vitality of our partnership on satellite navigation.

Thank you very much in advance for considering our request.

Yours sincerely,

Paul Weissenberg

Commission européenne, B-1049 Bruxelles / Europese Commissie, B-1049 Brussel - Belgium. Telephone: (32-2) 299 11 11.
Office: BREY 14/72. Telephone: direct line (32-2) 29 98918. Fax: (32-2) 2969400.

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EUROPEAN COMMISSION
ENTERPRISE AND INDUSTRY DIRECTORATE-GENERAL

EU Satellite Navigation Programmes
Director

Brussels, 08/12/2014,
ENTR/H3/GM/mc Ares (2014) 2812894

Mr Jonathan Margolis
Deputy Assistant Secretary
Bureau of Oceans and International
Environmental and Scientific
Affairs
U.S. Department of State
2201 C Street NW Washington,
D.C. 20520
United States of America

Dear Mr Margolis, Jonathan,

During the 2014 GNSS Plenary meeting which took place in Madrid, the issue of the Federal Communications Commission's (FCC) waiver for the Galileo program was further discussed and it was decided that the European Commission should send revised versions of the two documents already submitted, in order to address some additional U.S. questions.

Please find herewith attached the two revised documents: a note explaining how Galileo abides by the space debris mitigation guidelines and the FCC's "Schedule S" form completed with Galileo's information.

I hope that these documents now meet your requirements and that they will enable the U.S. authorities to grant the block exemption for Galileo reception in the U.S. as soon as possible.

Yours sincerely,

Matthias Petschke

Encl: - Revised Technical Note on Galileo Programme Compliance with United Nations Space Debris Mitigation Guidelines;

- Revised Galileo Schedule S.

Commission européenne, B-1049 Bruxelles / Europese Commissie, B-1049 Brussel - Belgium. Telephone: (32-2) 299 11 11.
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Technical Note on Galileo Programme Compliance with United Nations Space Debris Mitigation Guidelines

Reference	GAL-TN-ESA-NS-0016378	**Issue**	1
Date of Issue	23/07/2014	**Revision**	2

Authors	EC - X. Maufroid ESA - N. WATTS
Approved by:	EC: P.Flagel ESA: G.Gatti
Signatures	

Commission européenne/European Commission
European Space Agency
Agence spatiale européenne

Contents

1. SCOPE OF THIS NOTE

The Space Debris Mitigation Guidelines [Ref.1] of the UN Committee on the Peaceful Uses of Outer Space was adopted by the resolution 62/217 of the UN General Assembly in December 2007.

This objective of this note is to provide a short assessment of the compliance of the Galileo Programme with the United Nations Space Debris Mitigation Guidelines. The assessment is made based on the existing space segment and launch service requirements which are imposed by the Galileo Programme on the segment suppliers as well as the resulting space segment mission analysis and operations design.

2. REFERENCE DOCUMENTS

[Ref.1] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.

[Ref.2] Space Debris Mitigation for Agency Project – ESA Document, ESA/ADMIN/IPOL(2008)2

[Ref.3] Regulation (EC) No 683/2008 of the European Parliament and of the Council on the further implementation of the European satellite navigation programmes (European Geostationary Navigation Overlay Service (EGNOS) and GALILEO).

3. ACRONYMS

AOCS	Attitude and Orbit Control System
BCDR	Battery Charge and Discharge Regulator
COPUS	Committee for Peaceful Utilization of Space
EC	European Commission
ESA	European Space Agency
FDIR	Fault Detection Isolation and Recovery
FOC	Full Operational Capability (On-going deployment phase of the Galileo Programme)
HDRS	Hold Down and Release System
IADC	Inter-Agency Space Debris Coordination Committee
IOV	In-Orbit Validation (First Phase of the Galileo Programme)
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
OFE	Output Feared Event

SAR	Search and Rescue
S/C	Spacecraft
UN	United Nations

4. GALILEO PROGRAMME AND COMPLIANCE TO UN SPACE DEBRIS MITIGATION GUIDELINES

4.1. Preliminary Note

The Galileo Programme is governed according to a scheme defined in the EC Regulation 683/2008 [Ref.3] whereby the European Commission is the Galileo Programme Manager and the European Space Agency acts as the system architect and procurement agent for the Galileo system infrastructure. The European Space Agency, is therefore in charge to establish, on behalf of the European Commission, all contracts related to the Galileo satellites development and production and to the launcher services.

The European Space Agency, based on the IADC (Inter-Agency Space Debris Coordination Committee) Guidelines for Space Debris Mitigation and the Space Debris Mitigation Guidelines of the Scientific and Technical Subcommittee of the UN COPUOS, has developed its own Administrative Instruction on Space Debris Mitigation for Agency Projects [Ref.2]

This Administrative Instruction translates these Guidelines into applicable ESA Requirements and becomes an ESA applicable standard for all procurements of space systems, such as new launchers, satellites and inhabited objects, and of launch services for ESA procurements. This is therefore applicable to the Galileo procurements, as part of ESA's role as the Galileo procurement agent.

4.2. Overview of Galileo Space Segment Mission

The Galileo constellation is a Walker Delta 56° 24/ 3/1 constellation with 24 satellites[1] on 3 different orbital planes (+ 6 in-orbit spares).

The nominal orbit geometry of the overall 30 satellites is as follows:

- Numerical Eccentricity: 0.0001
- Inclination: 54° <i < 58°
- Semi-major Axis: 29600 km
- Orbit Period: ~14.1 h

The nominal Galileo Mission for the space segment operational phase is composed of:

- Launch phase: launch of the satellite, ascent to MEO and separation

[1] The current baseline of the Galileo constellation consists of 24 operational satellites and 6 in-orbit spares. However, the filing of the frequencies at ITU was made with the initial configuration of 27 operational satellites.

- Early operations and In-Orbit Test: Activation, attitude stabilization, solar array panels deployment, fine tuning of orbit position, checkout and calibration of satellite units
- Nominal operation and orbit maintenance: Nominal navigation and SAR mission operations
- Transition to Graveyard and Passivation: At the end of the mission, the satellite is moved into the graveyard orbit, remaining fuel is exhausted and the satellite is switched off with no possibility of battery charging.

For FOC Soyuz launches (2 satellites per launch), the satellites are directly injected into a drift MEO with a semi-major axis of 29900 km). This is the upper graveyard orbit for the Fregat upper stage and attached satellite dispenser (fully passivated to exhaust all fuel and other propulsives)

For FOC Ariane-5 launches (4 satellites per launch), the satellites are directly injected into a drift MEO with a semi-major axis of 29300 km). This is the lower graveyard orbit for the Ariane 5 transfer stage and attached satellite dispenser (fully passivated to exhaust all fuel and other propulsives).

For the IOV Soyuz launches (4 satellites on 2 Soyuz launches launched in October 2011 and 2012), the satellites were directly injected into a drift MEO with a semi-major axis of 29600 km). This is the final orbit altitude for the satellites; the Fregat upper stage and satellite dispenser is then raised to the graveyard orbit (+300km) and fully passivated to exhaust all fuel and other propulsives)

4.3. Galileo Programme Compliance to UN Guidelines on Space Debris Mitigation

4.3.1. Assessment #1: Limit debris released during normal operations

"Space systems should be designated not to release debris during the normal operations. If this is not feasible, the effect of any release of debris to the outer space environment should be minimized"

No debris is released during the operational phase of the Galileo satellites. The hold down and release systems (HDRS) at the satellite to dispenser interface retain all products within the mechanism, i.e. no debris is released at the time of the separation.

4.3.2. Guideline #2: Minimize the potential for break-ups during operational phase

"Spacecraft and launch vehicle orbital stages should be designed to avoid failure modes which may lead to accidental break-ups. In cases where a condition leading to such a failure is detected, disposal and passivation measures should be planned and executed to avoid break-up"

The Galileo satellites are designed with a comprehensive FDIR (Fault Detection Isolation and Recovery) system which minimises the occurrence of output feared events (OFE's)

and avoids the propagation of failures. The FDIR system is therefore designed to automatically intervene to recover from failures. No credible single failure can therefore cause loss of a Galileo satellite.

Furthermore, in case of major anomalies, the satellite will automatically transition to safe mode (sun pointing mode), in which the RF navigation signals are turned-off.

4.3.3. Guideline #3: Limit the probability of accidental collision in-orbit

"In developing the design and mission profile of spacecraft and launch vehicle stages, the probability of accidental collision with known objects during the system's launch phase and orbital lifetime should be estimated and limited..."

As far as the Galileo satellites are concerned, the main concern regarding possible collision is linked to the fact the satellites are separated from the dispenser in pairs. For the Ariane-5 launcher, the time between the separation of each pair of satellites will be at least 20 minutes.

Very strict requirements are established in the frame of the mission design to minimize the collision probability between the satellites or between the satellite and the launcher. The GALILEO-FOC requirement is to reach probability lower than 10^{-5} to have a minimum distance between each body lower or equal to 200 m. Following the detailed mission analysis performed by Arianespace, the requirement of 2.8×10^{-4} probability can be achieved with comfortable margins.

During the course of their operational life, the Galileo satellites will be operated in accordance with established collision avoidance procedures and the Galileo operator has the capability to perform collision avoidance manoeuvres to avoid conjunction with other large tracked objects in space.

Finally, at the end of life, the Galileo satellites are moved into their graveyard orbit (29900 km semi-major axis) to reduce the risk of future collisions in the operational slots/orbit.

4.3.4. Guideline #4: Avoid intentional destruction

"...the intentional destruction of any on-orbit spacecraft and launch vehicle orbital stages or other harmful activities that generate long-lived debris should be avoided."

It is not foreseen to destroy any Galileo satellite in-orbit, neither as part of the Galileo operational phase, neither as part of the design of the Galileo satellites.

4.3.5. Guideline #5: Minimize potential for post-mission break-ups resulting from stored energy

"In order to limit the risk to other spacecraft and launch vehicle orbital stages from accidental break-ups, all on-board sources of stored energy should be depleted or made safe when they are no longer required for mission operations or post-mission disposal."

In accordance with the European Code of Conduct for Space Debris Mitigation, the Galileo satellites will be completely passivated after reaching their graveyard orbit. The procedure in place for the Galileo satellites is the following:

- switch off payload
- perform propulsion system passivation ("fuel dumping" and depressurisation)
- electrically de-activate the satellite: no further RF transmission or reception possible

The Graveyard Phase is activated by ground at the end of the S/C operational life. During this phase the S/C is transferred to the graveyard orbit. While the specific steps for the manoeuvre are commanded, managed and updated through ground intervention, the autonomous recovery activities (FDIR) will be confined to satellite survival critical subsystems (TT&C, AOCS/Propulsion, Power,...). While performing the graveyard manoeuvre the FDIR will verify that the payload is deactivated.

When the satellite has entered its final position in the graveyard orbit the propulsion subsystem passivation will be carried out by depleting the remaining propellant in the tank. The depletion burns will be designed so that the satellite remains in graveyard position. The electrical passivation will then be achieved by patching/modifying the S/C configuration vector within the EEPROM part of the safeguard memory of the core computer to prevent reactivation (switch on) of the payload and all non-essential subsystems including AOCS units and S-Band transmitter by on-board software. This is followed by a final deactivation of all non-essential loads and a switch off of all BCDRs (Battery Charge and Discharge Regulators) which equates to a complete de-activation of the satellite.

By following this procedure, it is ensured that the satellites are left in a safe condition that minimizes the risk of debris creation (e.g. by explosions initiated by collision with any debris particle). The passivation of the propulsion system is performed via operation of the thrusters. Thereby, all remaining propellant is depleted down to the expulsion limit of the propellant tank (99.9% of the 64 kg of Hydrazine propellant). The operation of the thrusters will not displace the satellite from its graveyard position.

As far as the launcher is concerned, the Soyuz launcher upper stage (Fregat) will be fully passivated in order to minimise the risk of debris creation (i.e. emptying of tanks, release of internal pressure, etc) after insertion into graveyard orbit in line with ESA applicable "Requirements on Space Debris Mitigation for ESA Projects" [Ref. 2]. The emptying of the tank is performed by activating dedicated punchers, specifically included in the Fregat stage following a request of the Galileo project.

4.3.6. Guideline #6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the Low Earth Orbit (LEO) region after the end of their mission

This is not applicable to the Galileo system since the system operates in MEO region and apart from the transfer stage all other launcher orbital stages fall back to earth.

4.3.7. Guideline #7: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the Geosynchronous Earth Orbit (LEO) region after the end of their mission

This is not applicable to the Galileo system since the system operates in MEO region and launcher orbital stages fall back to earth except for the Soyuz (Fregat) or A5 upper stages which are placed into graveyard orbits at respectively 29900 and 29300 km.

5. CONCLUSIONS

This technical note has assessed that the Galileo Programme should be considered fully compliant with the UN guidelines related to Space Debris Mitigation.

FOR INFORMATIONAL PURPOSES ONLY

FCC 312
Schedule S

FEDERAL COMMUNICATIONS COMMISSION
SATELLITE SPACE STATION AUTHORIZATIONS
(Technical and Operational Description)

Page 1: General, Frequency Bands, and GSO Orbit

S1. GENERAL INFORMATION Complete for all satellite applications.

a. Space Station or Satellite Network Name: GALILEO MSATNAV-2/3/4	e. Estimated Date of Placement into Service: 01/01/2015	i. Will the space station(s) operate on a Common Carrier basis? ☐ YES ☑ NO
b. Construction Commencement Date:	f. Estimated Lifetime of Satellite(s): 15 Years	j. Number of transponders offered on a Common Carrier basis:
c. Construction Completion Date:	g. Total Number of Transponders: 2	k. Total Common Carrier Transponder Bandwidth:
d. Estimated Launch Date:	h. Total Transponder Bandwidth (No. Transponders x Bandwidth): 127 MHz	l. Orbit Type: Mark all boxes that apply. ☐ GSO ☑ NGSO

S2. OPERATING FREQUENCY BANDS Identify the frequency range and transmit/receive mode for all frequency bands inwhich this station will operate. Also indicate the nature of service(s) for each frequency band.

Frequency Band Limits					
Lower Frequency (_Hz)		Upper Frequency (_Hz)			
a. Numeric	b. Unit (K/M/G)	c. Numeric	d. Unit (K/M/G)	e. T/R Mode	f. Nature of Service(s): List all that apply to this band
1164	M	1215	M	T	RNSS
1260	M	1300	M	T	RNSS
1559	M	1591	M	T	RNSS

S3. ORBITAL INFORMATION FOR GEOSTATIONARY SATELLITES ONLY:

a. Nominal Orbital Longitude (Degrees E/W):

b. Reason for orbital location selection:

Longitudinal Tolerance or E/W Station-Keeping:
c. Toward West: _____ Degrees
d. Toward East: _____ Degrees

e. Inclination Excursion or N/S Station-Keeping Tolerance: _____ Degrees

Range of orbital arc in which adequate service can be provided (Optional): Degrees E/W
f. Westernmost: _____ ___
g. Easternmost: _____ ___

h. Reason for service arc selection (Optional):

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S4. ORBITAL INFORMATION FOR NON-GEOSTATIONARY SATELLITES ONLY

S4a. Total Number of Satellites in Network or System: 27
S4c. Celestial Reference Body (Earth, Sun, Moon, etc.): Earth
S4b. Total Number of Orbital Planes in Network or System: 3
S4d. Orbit Epoch Date:

For each Orbital Plane Provide:

(e) Orbital Plane No.	(f) No. of Satellites in Plane	(g) Inclination Angle (degrees)	(h) Orbital Period (Seconds)	(i) Apogee (km)	(j) Perigee (km)	(k) Right Ascension of the Ascending Node (Deg.)	(l) Argument of Perigee (Degrees)	Active Service Arc Range (Degrees)		
								(m) Begin Angle	(n) End Angle	(o) Other
1	9	56	51660	23616	23616	0	0			
2	9	56	51660	23616	23616	120	0			
3	9	56	51660	23616	23616	240	0			

S5. INITIAL SATELLITE PHASE ANGLE For each satellite in each orbital plane, provide the initial phase angle.

(a) Orbital Plane No.	(b) Satellite Number	(c) Initial Phase Angle (Degrees)	(a) Orbital Plane No.	(b) Satellite Number	(c) Initial Phase Angle (Degrees)	(a) Orbital Plane No.	(b) Satellite Number	(c) Initial Phase Angle (Degrees)	(a) Orbital Plane No.	(b) Satellite Number	(c) Initial Phase Angle (Degrees)
1	1	0	2	1	13.3	3	1	26.7			
1	2	40	2	2	53.3	3	2	66.7			
1	3	80	2	3	93.3	3	3	106.7			
1	4	120	2	4	133.3	3	4	146.7			
1	5	160	2	5	173.3	3	5	186.7			
1	6	200	2	6	213.3	3	6	226.7			
1	7	240	2	7	253.3	3	7	266.7			
1	8	280	2	8	293.3	3	8	306.7			
1	9	320	2	9	333.3	3	9	346.7			

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S6. SERVICE AREA CHARACTERISTICS For each service area provide:

(a) Service Area ID	(b) Type of Associated Station (Earth or Space)	(c) Service Area Diagram File Name (GXT File)	(d) Service Area Description. Provide list of geographic areas (state postal codes or ITU 3-ltr codes), satellites or Figure No. of Service Area Diagram.		
GLOBAL	E		GLOBAL BEAMS COVERAGE		

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S7. SPACE STATION ANTENNA BEAM CHARACTERISTICS For each antenna beam provide:

(a) Beam ID	(b) T/R Mode	Isotropic Antenna Gain (c) Peak (dBi)	Isotropic Antenna Gain (d) Edge (dBi)	(e) Pointing Error (Degrees)	(f) Rotational Error (Degrees)	(g) Min. Cross-Polar Iso-lation (dB)	(h) Polar-ization Switch-able? (Y/N)	(i) Polarization Alignment Rel. Equatorial Plane (Degrees)	(j) Service Area ID	Transmit (k) Input Losses (dB)	Transmit (l) Effective Output Power (W)	Transmit (m) Max. EIRP (dBW)	Receive (n) System Noice Temp-erature (K)	Receive (o) G/T at Max.Gain Pt. (dB/K)	Receive (p) Min. Saturation Flux Density (dBW/m2)	Receive Input Attenuator (dB) (q) Max. Value	Receive Input Attenuator (dB) (r) Step Size
DL1	T	16.2	13.5	0	0		N	RHCP	GLOBAL		18.4	34.6					
DL2	T	16.2	13.5	0	0		N	RHCP	GLOBAL		18.9	35.1					
DL3	T	16.2	12.9	0	0		N	RHCP	GLOBAL		20.7	36.9					

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Page 5: Beam Diagrams

S8. ANTENNA BEAM DIAGRAMS For each beam pattern provide the reference to the graphic image and numerical data:
Also provide the power flux density levels in each beam that result from the emission with the highest power flux density.

(a) Beam ID	(b) T/R Mode	(c) Co- or Cross-Polar Mode ("C" or "X")	(d) GSO Ref. Orbital Longitude (Deg. E/W)	(e) NGSO Antenna Gain Contour Description (Figure / Table / Exhibit)	(f) GSO Antenna Gain Contour Data (GXT File)	Max. Power Flux Density (dBW/m2 per Reference Bandwidth*) At Angle of Arrival above horizontal (for emission with highest PFD)					(l) Reference Bandwidth* (4kHz or 1MHz)
						(g) 5 Deg	(h) 10 Deg	(i) 15 Deg	(j) 20 Deg	(k) 25 Deg	
DL1	T	X				-118.45	-118.29	-118.12	-117.97	-117.81	1MHz
DL2	T	X				-117.95	-117.79	-117.62	-117.47	-117.31	1MHz
DL3	T	X				-116.15	-115.99	-115.82	-115.67	-115.51	1MHz

*Use a Reference Bandwidth of 4 kHz or 1 MHz as appropriate to the FCC Rules that apply to the subject frequency band (§ 25.208).

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Page 6: Channels and Transponders

S9. SPACE STATION CHANNELS For each frequency channel provide:

(a) Channel No.	(b) Assigned Bandwidth (kHz)	(c) T/R Mode	(d) Center Frequency (MHz)	(e) Polarization (H,V,L,R)	(f) TT&C or Comm Channel (T or C)
1	55,000	T	1191.5	R	C
2	40,000	T	1280	R	C
3	32,000	T	1575.42	R	C

S10. SPACE STATION TRANSPONDERS** For each transponder provide:

(a) Transponder ID	(b) Transponder Gain* (dB)	Receive Band		Transmit Band	
		(c) Channel No.	(d) Beam ID	(e) Channel No.	(f) Beam ID
1	N/A			1	DL 1
2	N/A			2	DL 2
3	N/A			3	DL 3

*Transponder gain between output of receiving antenna and input of transmitting antenna.
**Also complete this table for half-links such as TT&C and on-board processing. In such cases, provide the receive or transmit information, as appropriate.

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S11. DIGITAL MODULATION PARAMETERS For each digital emission provide:

(a) Digital Mod. ID	(b) Emission Designator	(c) Assigned Bandwidth (kHz)	(d) No. of Phases	(e) Uncoded Data Rate (kbps)	(f) FEC Error Correction Coding Rate	(g) CDMA Processing Gain (dB)	(h) Total C/N Performance Objective (dB)	(i) Single Entry C/I Objective (dB)
E5	55M0G7W	55000						
E6	40M0G7W	40 000						
E1	32M0G7W	32000						

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S12. ANALOG MODULATION PARAMETERS For each analog emission provide:

(a) Analog Mod. ID	(b) Emission Designator	(c) Assigned Bandwidth (kHz)	(d) Signal Type* (see below)	(e) Channels per Carrier	Multi-channel Telephony				(j) Video Standard NTSC, PAL, etc.	(k) Video Noise Weighting (dB)	(l) Video & SCPC/FM Modulation Index	(m) SCPC/FM Compander, Preemphasis, & Noise Weighting (dB)	(n) Total C/N Performance Objective (dB)	(o) Single Entry C/I Objective (dB)
					(f) Ave. Companded Talker Level (dBm0)	(g) Bottom Baseband Freq. (MHz)	(h) Top Baseband Freq. (MHz)	(i) RMS Modulation Index						

*Indicate whether signal is (a) FDM/FM, (b) CSSB/AM, (c) SCPC/FM, or (d) TV/FM.

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S13. TYPICAL EMISSIONS For each planned type of emission provide:

Associated Transponder ID Range		Modulation ID		(e) Carriers per Transponder	(f) Carrier Spacing (kHz)	(g) Noise Budget Reference (Table No.)	(h) Energy Dispersal Bandwidth* (kHz)	Receive Band (Assoc. Transmit Stn)			Transmit Band (This Space Station)				
								(i) Assoc. Stn Max. Antenna Gain (dBi)	Assoc. Station Transmit Power (dBW)		EIRP (dBW)		Max. Power Flux Density		(p) Assoc. Stn Rec. G/T (dB/K)
(a) Start	(b) End	(c) Digital (Table S11)	(d) Analog (Table S12)						(j) Min.	(k) Max.	(l) Min.	(m) Max.	(n) dBW/m2	(o) Ref. BW** (4kHz or 1MHz)	
1164 MHz	1219 MHz	ES										34.6			
1260 MHz	1300 MHz	E6										35.1			
1559 MHz	1591 MHz	E1										36.9			

* For those emissions using energy dispersal, provide the bandwidth of the energy dispersal. Otherwise, leave blank.
**Use a Reference Bandwidth of 4 kHz or 1 MHz as appropriate to the FCC Rules that apply to the subject frequency band (§ 25.208).

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S14. Is the space station(s) controlled and monitored remotely? If YES, provide the location and telephone number of the TT&C control point(s). ☑ YES ☐ NO

Remote Control (TT&C) Location(s):

S14a. Street Address			
S14b. City: Svalbaad	S14c. County	S14d. State / Country: Norway	S14e. Zip Code
S14f. Telephone Number	S14g. Call Sign of Control Station (if appropriate)		

S14a. Street Address			
S14b. City: Kourou	S14c. County: FRENCH GUIANA	S14d. State / Country: FRANCE	S14e. Zip Code
S14f. Telephone Number	S14g. Call Sign of Control Station (if appropriate)		

S14a. Street Address			
S14b. City: Papeete	S14c. County: FRENCH POLYNESIA	S14d. State / Country: FRANCE	S14e. Zip Code
S14f. Telephone Number	S14g. Call Sign of Control Station (if appropriate)		

S14a. Street Address			
S14b. City: Redu	S14c. County	S14d. State / Country: Belgium	S14e. Zip Code
S14f. Telephone Number	S14g. Call Sign of Control Station (if appropriate)		

S14a. Street Address			
S14b. City: Nouméa	S14c. County: NEW CALEDONIA	S14d. State / Country: FRANCE	S14e. Zip Code
S14f. Telephone Number	S14g. Call Sign of Control Station (if appropriate)		

S14a. Street Address			
S14b. City: SAINTE CLOTILDE	S14c. County: LA REUNION	S14d. State / Country: FRANCE	S14e. Zip Code
S14f. Telephone Number	S14g. Call Sign of Control Station (if appropriate)		

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S15. SPACECRAFT PHYSICAL CHARACTERISTICS

S15a. Mass of spacecraft without fuel (kg)	Spacecraft Dimensions (meters)	Probability of Survival to End of Life (0.0 - 1.0)
S15b. Mass of fuel & disposables at launch (kg)		
S15c. Mass of spacecraft and fuel at launch (kg)	S15f. Length (m)	S15i. Payload
S15d. Mass of fuel, in orbit, at beginning of life (kg)	S15g. Width (m)	S15j. Bus
S15e. Deployed Area of Solar Array (square meters)	S15h. Height (m)	S15k. Total

S16. SPACECRAFT ELECTRICAL CHARACTERISTICS

Spacecraft Subsystem	Electrical Power (Watts) At Beginning of Life		Electrical Power (Watts) At End of Life	
	At Equinox	At Solstice	At Equinox	At Solstice
Payload (Watts)	(a)	(f)	(k)	(p)
Bus (Watts)	(b)	(g)	(l)	(q)
Total (Watts)	(c)	(h)	(m)	(r)
Solar Array (Watts)	(d)	(i)	(n)	(s)
Depth of Battery Discharge (%)	(e) %	(j) %	(o) %	(t) %

S17. CERTIFICATIONS

a. Are the power flux density limits of § 25.208 met?	☐ YES	☐ NO	☑ N/A
b. Are the appropriate service area coverage requirements of § 25.143(b)(ii) and (iii), or § 25.145(c)(1) and (2) met?	☐ YES	☐ NO	☑ N/A
c. Are the frequency tolerances of § 25.202(e) and the out-of-band emission limits of § 25.202(f)(1), (2), and (3) met?	☐ YES	☐ NO	☑ N/A

In addition to the information required in this Form, the space station applicant is required to provide all the information specified in Section 25.114 of the Commission's rules, 47 C.F.R. § 25.114.